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SECTORAL TECHNOLOGY STRATEGY SERIES

No 11

The Canadian Food and Beverage Sector

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NO. 11 THE CANADIAN FOOD AND BEVERAGE SECTOR

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Highlights

- Food and beverage is Canada's second largest manufacturing sector. It faces increased competition and globalization of firms; changing consumer preferences and technology; and growing concerns about food nutrition and safety and about the environmental impact and implications for sustainability of current products and processes.

- Globalization and increasing economic concentration are occurring in those food subsectors characterized by non-staple "life style" products; promotion of truly global brands is easier than promotion of foodstuffs and beverages more sensitive to national and regional variation in tastes.

- A variety of factors is forcing the Canadian sector to rethink how it does business. Increasingly, products must be competitive in quality and price in both domestic and American markets. The North American food market is changing from a mass market to many niche or specialty markets, placing new demands on farmers, fishermen, and food processors and creating important new opportunities.

- Many food companies are targeting smaller market niches and paying more attention to product development and marketing.

- The pace of new product introduction in the food and beverage sector is accelerating. Wholesome products are being emphasized, and convenience foods are growing in variety and ingenuity.

- Economies of scale may be important in handling standard food products, but economies of scope are more important in serving niche markets. A particularly lucrative niche appears to be "green" products.

- In both the meat- and fish-processing subsectors, the global trend is toward value-added products.

- In today's global environment, the key competitive factors will be timely identification of market opportunities through close linkages to customers, commitment to quality, and willingness to take the risks involved in both product and process innovation.

- Product innovation in the food and beverage sector is a highly risky enterprise requiring deep pockets and the ability to absorb a high failure rate. It can also be highly rewarding.

- Investment in R&D by food and beverage companies is low compared with that of other manufacturing sectors virtually everywhere in the developed world. In part this is because of the food and beverage sector's reliance on R&D undertaken by other sectors, including equipment and packaging manufacturers.

- International competitive pressures and strong consumer interest in food quality and safety will accelerate the adoption of new technology. Potentially fundamental changes will arise from the application of robotics, biotechnology, and communication technologies — all of which will be vital in pursuing new opportunities.

- As a net exporter, the Canadian food and beverage sector exports almost 15 per cent of its shipments, mostly to the United States. Its major exports still tend to be commodity products.

- Canada's top food and beverage companies are often diversified concerns but are small by international standards. The Canadian sector is undergoing significant consolidation and restructuring.

- R&D expenditures by the Canadian food and beverage sector remained low throughout the 1980s; the Canadian sector's investment in R&D as a percentage of sales was less than half the U.S. rate. The sector is one of the few in Canada in which foreign subsidiaries are relatively more R&D-intensive than Canadian-controlled firms. The private sector also accounts for only 8 per cent of Canada's agri-food research spending, a level much lower than that in most other industrialized nations.

- Canadian agri-food R&D is focused at the front end of the food chain rather than on the later food-processing stage — a situation that does not augur well in an era of increasing numbers of specialty markets driven by customer preferences.

- Canadian food and beverage companies generally follow a strategy of local adaptation and adoption of foreign technologies. There are only a few Canadian companies that have innovative R&D programs.

- Since 1980 the four major Canadian food and beverage R&D performers have significantly reduced their R&D staff while focusing their business strategies in large part on their existing core activities, rather than on new areas.

- The food and beverage sector's attempt to address research issues on a cooperative basis — linking interagency research capabilities and creating interdisciplinary research teams through the Food Network — is an important recent development. That network now includes all the major players in Canadian food-processing and related research.

- Some food subsectors in Canada see the rising costs of raw materials — including those under supply management — as a major threat to competitiveness. Complaints about supply management are countered by criticism of the inefficiency and low productivity of processors' operations, a consequence, in part, of too many small plants.

- Canada's food processors feel ill prepared to face the new conditions arising from the Canada-U.S. Free Trade Agreement and the rise in global competition expected in the 1990s. They do, however, see R&D and the application of technology as key determinants of future success.

- A major block to the effective use of innovative technology is the business and financial risk taking required to scale up developments to commercial operations.

- A number of steps can be taken to promote research-driven innovation: change the corporate culture; invest in training and employee development; improve internal and external communications; delegate responsibility for innovation as much as is feasible to the plant level; recognize and reward innovation; use multidisciplinary teams; monitor technology closely; establish technology exchange agreements; develop a customer focus; and encourage risk taking.

- The food and beverage sector's competitiveness appears constrained by insufficient vision and commitment on the part of the private sector to seeking out technological opportunities, partnerships, and collaborative R&D with universities and governments; such backing would help drive innovation. The recent formation of the Food Network is a positive sign that the sector may be gearing up to overcome this limitation.

- Emerging conditions increase the onus on governments to cooperate with the private sector in developing an integrated agri-food policy to improve resource allocation for R&D and to heighten the sector's competitiveness.

- Emerging conditions also place an onus on food and beverage firms to give serious attention to environmental concerns, perhaps by forming environmental task forces and commissioning environmental audits.

Background to the Sectoral Technology Strategy Series

In the emerging "new" economy of the 1990s, successful high-value businesses in advanced nations are being driven by innovation, propelled by spending on new products and processes. Their business strategies centre increasingly on specialized knowledge and skill in finding the right "fit" between their unique blend of core technologies and particular markets.

Where does Canada stand in this rapidly evolving new environment of changing linkages and relationships? The poor innovative capacity of Canadian industry has long been a concern of the Science Council of Canada, going back to its 1971 report *Innovation in a Cold Climate*. The Council re-emphasized this concern in 1988. It focused its attention on the potential for action at a sectoral level in its statement *A Sectoral Approach to Innovation*. It argued:

> There is growing recognition by industry and government in Canada of the key role played by technology and R&D in domestic and international competition. The Science Council considers that it is primarily the responsibility of industries to raise the degree of domestic technological sophistication and the level of R&D. Nevertheless, governments can help business to sustain long-term competitiveness both by building partnerships with individual firms and by generating consensus on the formulation of innovation strategies for the various industrial sectors. The intent is not for government to tell business what to do, but to facilitate business cooperation in a process of self-help. The process of building consensus on a strategy for a particular sector will involve close and on-going consultation with industries about the current role of technology and R&D in the sector, the opportunities foreseen, and the nature of the sources, stimuli, and forms of technological innovation. Obviously, to be successful, separate innovation strategies will be needed for each sector. The Science Council hopes that the process of building consensus will generate commitment and collective will concerning priorities, areas for cooperation, and agenda for action.

This 1988 statement proved to be an important step in the path that subsequently led the Council to undertake a major Sectoral Technology Strategy project.

In 1989, Industry, Science and Technology Canada, at a time of heightened concern for the state of Canadian competitiveness and serious questioning about the low level of Canada's gross expenditures on research and development as measured against other advanced countries, agreed to provide the main funding for this project. It also stipulated the selection of sectors on which it would like the project to focus.

Each report in this Sectoral Technology Strategy Series draws in part upon analyses commissioned by the Science Council of Canada from contractors, designed to reveal the key dynamics driving technological innovation in the sector and influencing company technology strategies. Each report has also benefited considerably from the comments and advice submitted by the many external reviewers from business, universities, and government, who are recognized in the Acknowledgements.

Commentary on the Sectoral Technology Strategy Series and R&D Targets

The Sectoral Technology Strategy Series has analysed 15 Canadian sectors. On the basis of this experience, the Science Council of Canada makes the following points with regard to Canadian R&D performance and the issue of setting sectoral R&D targets.

- Canadian firms, when grouped by sectors, generally perform much less R&D than their trade competitors. Using the indicator of R&D as a percentage of sales, Canadian firms undertake R&D at a rate about one-third to one-half the rate of their leading international sectoral competitors. The notable exception among those sectors analysed in telecommunications.

- In some product lines or specific technologies certain absolute threshold levels of R&D and capital investment must be reached if the effort is to be considered to have a chance of making a commercial payback. High thresholds are apparent in some parts of sectors such as telecommunications (central office switches), automotive parts ("Tier 1" supplier status), oil and gas (reformulated gasoline standards by refineries), and electronics (integrated circuit foundry). Such absolute thresholds cannot be clearly expressed as a percentage of sales.

- The reasons for the lower level of R&D spending by firms in most of the 15 Canadian sectors are: choice of business and technology strategy (which, in part, leave Canadian companies as essentially non-participants in many higher value-adding segments); the relatively small size of Canadian firms; the high absolute thresholds of R&D expenditure required to be a meaningful player, especially for innovative technology strategies; and the degree of foreign ownership of Canadian firms (especially important in the case of the automotive vehicles and parts sectors).

- The lack of R&D relative to other countries affects Canadian competitiveness, but it is only one of many factors, such as capital and labour costs, quality design, good marketing, and management, that interact to affect overall competitiveness. Nevertheless, the contribution of R&D, or more precisely, technology-based innovation, is becoming more pronounced throughout the global economy and Canada continues to fall behind. The low level of R&D is especially detrimental to the capacity of Canadian resource-based sectors to compete with higher-value, differentiated products, leaving them vulnerable to adverse shifts in costs beyond their control, such as a higher exchange rate.

- Major potential does exist for Canadian industry to make additional R&D investments. However, fulfilling this potential depends heavily on the vision and capability of management to make strategic use of technology, to speed the firms' innovation process, to work more closely with suppliers and "demanding customers" all the way to the end of the product chain, and to build core capabilities in incremental innovation and R&D. Canadian firms have not yet fully grasped the implications of the emerging new "lean enterprise" or "agile producer" strategy. To follow this new strategy involves seeking to offer maximum value to customers. It requires integrating the skills base of a knowledgeable workforce with flexible management structures that stimulate cooperative initiatives within and between firms to match customer needs.

- The dominant technology strategies being followed by Canadian firms in these sectors are of adopt and adapt. Innovation technology strategies are not very extensive (telecommunications is again an exception) and hardly any firms focus on breakthrough strategies to enhance competitiveness. Overall, these 15 sectors show little attempt at diversification out of existing product lines as opposed to making such products more efficiently.

- Governments can set sectoral R&D targets in the hope of stimulating enhanced industrial performance, shifts in business strategy, and greater commitment by the private sector to R&D. However, private sector R&D is only meaningfully undertaken in conjunction with a full complement of associated private and public sector actions ranging from improved design and production to finance and marketing. Doing more R&D will not be productive unless linked to a broader corporate technology strategy that is carefully designed to support the firm's business objectives. Otherwise, the corporation cannot, and will not, marshal the complementary investments required to reap the benefits of the R&D. It is the firm that must commit R&D resources.

- Setting sectoral R&D targets becomes more difficult as the boundaries between sectors are breaking down, through technological advances, regulatory change, and firm restructuring. Larger and more diversified firms that dominate modern industrial R&D perform R&D that might be allocated to any of several sectors. Examples include the textiles and materials R&D performed by large Japanese steel firms, the electronics R&D by automotive-vehicle firms, and the software R&D by telecommunications firms. Canadian governments have quite correctly encouraged higher levels of industrial R&D in Canada. In view of the rapid pace of scientific advances and technological change, plus the role of system interdependencies and synergies between technologies, setting R&D targets does not appear to be a task warranting the intensive effort, cooperation, and, ultimately, commitment that would be required by federal and provincial governments and private sector organizations.

List of Sectoral Technology Strategy Series Reports

No. 1 The Canadian Telecommunications Sector
No. 2 The Canadian Automotive-Parts Sector
No. 3 The Canadian Iron and Steel Sector
No. 4 The Canadian Automotive-Vehicle Sector
No. 5 The Canadian Oil and Gas Sector
No. 6 The Canadian Petrochemicals and Resins Sector
No. 7 The Canadian Banking Sector
No. 8 The Canadian Nonferrous-Metals Sector
No. 9 The Canadian Forest-Products Sector
No. 10 The Canadian Machinery Sector
No. 11 The Canadian Food and Beverage Sector
No. 12 The Canadian Electric-Power Sector
No. 13 The Canadian Consulting-Engineering Sector
No. 14 The Canadian Electronics Sector
No. 15 The Canadian Computer Software and Services Sector

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Introduction

Food and beverage is Canada's second largest manufacturing sector, generating revenues of $43 billion a year. The sector touches every Canadian as a consumer, but it also, directly and indirectly, employs a huge diversity of people, including transportation workers, meat packers, canners, packagers, advertising professionals, market researchers, grocery wholesalers, and retailers.[1]

The Canadian food and beverage sector has entered an era characterized by increasing global interdependence and competition. As a result, consumers in Canada and other countries can today buy food from all over the world, enjoying greater variety, convenience, and quality; and, in some cases, less expensive food. For food processors, globalization means increased competition and growing market opportunities; falling trade barriers are opening up new markets and forcing much of the industry to compete internationally to a greater extent. A further consequence of globalization is increasing consolidation, joint ventures, mergers, and acquisitions as companies acquire the muscle they need to compete internationally.

In addition to globalization, the industry is increasingly being driven by changing consumer preferences and technology, growing concerns about nutrition and food safety, and rising fears about the environmental impacts of current products and processes and their implications for sustainable agri-food systems. People care about what they eat and will quickly shun the apparently hazardous — as shown by the recent food scares concerning Alar on apples, salmonella in eggs, and cyanide on grapes — and support the apparently nutritious — as shown by the recent fad for oats, which fizzled following a medical study questioning the effectiveness of oats in reducing cholesterol.

All these factors are forcing the Canadian sector to rethink how it does business. If Canadian food and beverage companies are to survive and prosper, they must respond effectively to these forces. Their products must be competitive in quality and price and in domestic and foreign markets. The North American food market is changing from a mass market to many niche or specialty markets, thereby placing new demands on farmers, fishermen, and food processors and raising significant new opportunities. Many food companies are accordingly targeting smaller market niches and pursuing a business strategy that requires more careful product development and marketing.[2]

The main objectives of this report are to review the technology strategies pursued by leading food and beverage firms and to compare Canada's R&D performance with that of its main trade competitors, outlining the major reasons for any differences and how those differences affect Canada's competitiveness.

Overview of the Global Food and Beverage Sector

The Global Market

The pace of innovation and new product introduction in the food and beverage sector is accelerating. In 1991, some 14 000 new edible items were launched by processors in Canada and the United States — a figure up sharply from some 12 000 in 1989, and double the number of five years ago. These new products allow us to discern key trends in the international food market.[3]

For example, new products introduced in the last several years have been dominated by items advertised as "healthy and wholesome." A recent consumer survey by the Grocery Products Manufacturers of Canada (GPMC) illustrates how increasing concerns about wholesomeness and nutrition have changed consumer buying patterns and attitudes. The price sticker remains the first thing that consumers look for on new food products, but 80 per cent also read the ingredient label; more than half look for the sugar, fat, calorie, fibre, sodium, and cholesterol content (in that order).[4]

Processors have responded to consumer preferences with diet soft drinks, low-calorie entrées, high-fibre cereals, light beers, preservative-free fresh food, and fat-reduced or fat-free items. A glance around any supermarket will reveal a feast of "lite" desserts, "100 per cent natural" potato chips, and "high-fibre" cereals.[5]

The rewards for a successful healthful and wholesome product are substantial. Imagine a product that earns 45 cents of profit on every $1.00 of sales and you can appreciate the worldwide interest in breakthrough products in this area. According to industry analysts, Monsanto earned $330 million in profits on sales of $736 million for NutraSweet aspartame during 1988.[6]

A potentially profitable new area is products made with fat substitutes, such as those developed by Kraft General Foods, A.E. Staley, Procter & Gamble, and NutraSweet. As they win government approval, they could snowball into a category as big as "lite" products. On average, lower-calorie versions of standard products contributed about 10 per cent to food producers' sales in 1989.[7]

Another trend evident in new product introduction is an emphasis on products and packaging that appeal to children and teenagers. The junior market previously centred on cereals, cookies, and candy. However, retailers and processors now see major profits in expanding that market. Today's children, the rationale goes, have tremendous buying power. Not only do they strongly influence the food items that their parents purchase, but, thanks to the rise in dual-income families, many of them are directly responsible for regularly filling the household shopping basket.[8]

Predictably, convenience-food products continue to grow in variety and ingenuity as busy consumers look for new ways to save time and cut corners in food preparation. The demand for frozen and microwaveable foods, for example, continues to surge. Packaged meals, particularly for breakfast and lunch, are making a strong showing as well, as are items that have been pared down to single-serving size.[9]

In another change, major food companies — including industry leaders such as Pillsbury, Campbell, and Dole — are becoming more involved with "produce branding." Apparently, consumers feel better buying fresh fruits and vegetables that have a well-known supplier. Currently only about half the produce sold in North American supermarkets is identified by brand; moreover, whereas frozen and canned produce sales have hit a plateau, consumption of fresh produce is rising.[10]

While consumer tastes are still distinctly different in each country, they are becoming more homogeneous. Accordingly, economies of scale in production and marketing are important. Marginal brands without a strong marketing image will likely find it increasingly difficult to compete for shelf space.

At the same time, market niches cannot be overlooked. In Japan, French fries are making inroads in the traditional rice diet. In North America, the growing popularity of products such as chicken fingers and nuggets, pizzas, and Mexican foods has spawned opportunities at the grocery store level. Retailers, not just manufacturers, can develop, and are developing, these markets. Specialty preserves, gourmet meals (whether fresh or frozen), and premium ice cream and yogurt serve small but generally upscale markets. Some of these niche markets may prove too small or difficult for large food processors to serve profitably, but they present ideal opportunities for small to medium-sized processors. It seems that whereas economies of scale may be important in the handling of standard food products, economies of scope are more important in serving niche markets.[11]

The so-called "green" products look particularly lucrative as a market niche. In June 1989, Loblaws Supermarkets changed the face of the Canadian grocery industry by launching a line of "G.R.E.E.N." products. These are environmentally friendly products that help reduce pollution, and many were developed in consultation with environmental groups. Among the products are phosphate-free detergent, diapers, and fertilizer. Despite criticism from environmental groups for being opportunistic and misleading the public, Loblaws has apparently benefited.[12] It has established a lead in green products — a lead that resulted in $5 million in sales in the first month and continuing sales of about $500 000 a week during the first six months. Another plus is the strong environmental identification Loblaws has gained with the public. According to Dave Nichol, president of Loblaw International Merchants, "the data clearly indicated that people are willing to change supermarkets to buy G.R.E.E.N. products." In addition, Loblaws has been able to market its G.R.E.E.N. products to a number of U.S. supermarket chains.[13]

However, marketers are in something of a quandary, unsure whether "greening" is, in fact, a long-term proposition or a short-term fad. Are consumers willing, over the long term, to put their money where their mouths are and to give up convenience for environmental soundness?

The meat industry is now seriously trying to accommodate the global trend toward value-added, fresh products. Besides producing more processed meats, it is also experimenting with such items as pre-cooked pork roasts and brand-name, fresh pepper steak.[14] In Canada, Maple Leaf Foods Inc. has developed brand-name pork roasts and is interested in their export potential, while Schneider Corporation in Kitchener, Ontario, is establishing its brand-name processed meats in the northeastern United States. "Commodity" is becoming a dirty word when applied to meat.[15]

The fish industry is also making a move to value-added products. For example, Canada's Fishery Products International (FPI) recently repositioned cod with two upscale cod fillet lines: Imperial Cod and Regal Cod. FPI has designed both these lines for the American food-service industry, where it is now the market leader.[16]

Overall, then, it is clear that product life cycles are becoming increasingly short. In North America, thousands of food products are introduced every year, but only a handful survive. New product introductions still require marketing strength to be successful, but corporate flexibility will be the key to serving the wide range of specialized and niche markets that are expected to emerge in the 1990s. In this global environment, key competitive factors will be the timely identification of market opportunities through close linkages to customer issues, a commitment to quality, and the willingness to take the risks involved in product and process innovation.[17]

The Global Sector

The food and beverage sector is one of the world's most important sectors, with seven food companies among the world's 100 biggest industrial corporations (based on sales).[18] With worldwide food sales of $27 billion in 1988 and a workforce of more than 170 000 people, Nestlé, headquartered in

Switzerland, is the world's largest food company. Tables 1 and 2 give an indication of the size, in sales, of leading U.S. and European food processors.

Table 1. Top 10 food and beverage companies in the United States (1988)

Company	Processed food sales (U.S.$ billions)	Total sales (U.S.$ billions)
Philip Morris	13.2	25.9
RJR Nabisco	10.3	17.0
Kraft	10.0	11.3
IBP	9.0	9.0
Pepsico	8.5	13.0
Coca-Cola	8.0	8.3
Anheuser-Busch	7.6	8.9
ConAgra	6.9	9.5
Mars	6.8	7.5
A.D. Midlands	6.2	6.8
Total	86.5	117.2

Source: U.S. Department of Agriculture, Economic Research Service, *Largest Global Food Processing Firms, 1988* (Washington, D.C.).

Table 2. Top six food processors in Europe (1988)

Company	Processed food sales (U.S.$ billions)	Total sales (U.S.$ billions)
Nestlé (Switzerland)	27.0	27.8
Unilever (United Kingdom, Netherlands)	15.2	30.4
BSN (France)	6.2	7.1
Allied-Lyons (United Kingdom)	5.9	5.9
Bass (United Kingdom)	5.8	5.8
Hillsdown Holdings (United Kingdom)	5.0	6.3

Source: U.S. Department of Agriculture, Economic Research Service, *Largest Global Food Processing Firms, 1988* (Washington, D.C.).

Historically, even the larger North American and European food processors have concentrated their efforts in their home markets. For example, roughly half of Nestlé's sales are in Europe.[19] However, with the dismantling of trade barriers and the move to globalization, the food and beverage firms are moving aggressively to capture markets around the world. To do this, they are using a variety of means to consolidate and concentrate their resources, including joint ventures, mergers, and

acquisitions. Such measures are often viewed as a fast route to broadening a firm's product line and one that may be cheaper than building new capacity. They also add to the corporate critical mass of resources necessary to be competitive internationally. The ability to realize optimum economies of scale can be important in keeping mass-marketed food products or staples priced competitively.[20]

For particular grocery items, long-term profitability increasingly hinges on the worldwide reach of powerful brands. Brands are expensive to maintain, in terms of advertising effort, and even more costly to create. They are, however, powerful marketing weapons. For example, rather than building an American market for its High Liner label, Canada's National Sea Products purchased the American fish-processing firm, Booth Fisheries, using the Booth label to gain an immediate market presence in the United States.[21] Interestingly, promotion of truly global brands appears to be more readily achieved with the "life style," non-staple products, such as alcoholic beverages, soft drinks, and confectionery items, than with foodstuffs more sensitive to national and regional variation in tastes. Globalization and increased economic concentration are thus increasingly common in these "life style" food subsectors.

A good example of the growing competition in the global marketplace is the billion-dollar battle shaping up in the world's ready-to-eat breakfast cereal market. Ready-to-eat cereal is one of the most profitable and fiercely marketed of all consumer products. Kellogg, with annual sales of U.S.$5.2 billion, sells its Corn Flakes, Rice Crispies, and Frosted Flakes in 130 countries around the world. It earns 35 per cent of its profits outside the United States. Challenging Kellogg for global market share is Cereal Partners Worldwide (CPW), a new joint venture of General Mills and Nestlé — the food industry's first major joint venture designed to be a global business.[22] CPW should have a tactical advantage over Kellogg in Asia, Africa, and Latin America because of Nestlé's status as a food powerhouse in those markets and the fact that Kellogg produces only cereal.[23]

These two giants have chosen Europe as their first battlefield. Starting from its U.S. base, Kellogg built a European market from scratch, first in Britain during the 1920s and then on the Continent during the 1950s. Today, it has about half the European market. Now CPW is trying to muscle in.[24] With the help of Nestlé's power as a major supplier of food products, CPW persuaded the Continent's large retailers to put its cereals on the shelves alongside Kellogg's.[25]

But Kellogg retaliated. To counter the recent appearance in Europe of Honey Nut Cheerios, the second-best-selling General Mills brand in the United States, Kellogg introduced a product called Honey Nut Loops. The two boxes look very similar, and it would take a cereal connoisseur to taste the difference. Similar "clones" are planned for other CPW brands.[26] In a business where rolling out a new product can cost $35 million for the marketing alone, counterpunching is an expensive way for Kellogg to defend its share; Kellogg evidently finds the investment worthwhile, however, when world markets are at stake.[27]

The global cereal war points out some important lessons about competition in today's food and beverage industry. The key to success in the global marketplace is the capital, knowledge, and technology required to develop, produce, and market new products, rather than the raw ingredients themselves. Thus, although the breakfast cereal business uses cheap commodities as its raw materials, the industry is essentially capital-, knowledge-, and marketing-intensive. The major ways for companies to acquire the resources, know-how, and technology needed to compete effectively in the global marketplace are through joint ventures, mergers, and acquisitions.

Indeed, in addition to CPW, Nestlé is involved in several other joint ventures. It has a deal with Coca-Cola, for example, whereby the beverage giant distributes Nestlé instant coffee and tea throughout the world. Through a deal with Baxter International, Nestlé distributes food substitutes for hospital patients.[28] Nestlé is also going the acquisition route: it recently purchased the American milk producer Carnation (at a cost of U.S.$3 billion) and Rowntree, the British food company (at a cost of U.S.$4.5 billion).[29]

Other recent European acquisitions include Philip Morris's purchase of Swiss chocolate and coffee purveyor Jacobs Suchard for U.S.$3.8 billion. The deal more than doubles Philip Morris's European sales, to U.S.$8 billion, thus raising the company to third place in the world — behind Nestlé and Unilever — and moving it closer to its desired position as the world's leading food company.[30] Cadbury is buying as well: it paid U.S.$215 million for Source Perrier's soft-drink operations in Europe, after snaring the British candy maker Trebor; it has also picked up Bassett Foods and the U.S. soft-drink maker Crush International. United Biscuits (Holdings) plc bought the Dutch cookie maker Verkade in May 1990 for U.S.$160 million, while France's BSN recently bought U.S.$2.5 billion worth of RJR Nabisco businesses and took over two pasta makers, West Germany's Birkel and Italy's Agnesi. Unilever, Europe's second largest food company, recently purchased at least 11 food companies, including cheese maker Boursin in France and Spanish olive-oil processor Cosablanca.[31]

The same trend toward consolidation has struck the North American food and beverage industry as well. For example, soft-drink giant Coca-Cola entered the joint venture arena with its cosponsorship, with Disney, of the 1991 Super Bowl half-time show. Coca-Cola is also on the acquisition trail.[32] Unhappy with longtime bottler Groupe Pernod Ricard in France, Coca-Cola bought the business outright in 1989; by 1990, French volume had increased 23 per cent.[33] Coca-Cola's overseas operating income is now almost 77 per cent of the company's total operating income of almost U.S.$2 billion, up from 53 per cent in 1985. And with non-U.S. consumption of Coca-Cola's soft drinks averaging only about 56 servings per person a year, compared with 283 in the United States, there is still plenty of room for growth.[34]

The anecdotal evidence of industry consolidation in Europe and North America is supported by statistical trends. In the European packaged food industry, acquisitions have more than doubled since 1985 — from an annual average of 20 to more than 40 — and the trend is expected to accelerate.[35] In the United States, the long-term trend to industry consolidation is clear: from over 42 000 companies in 1947, the net number of food-processing companies had declined by over 25 000 companies, or 60 per cent, by 1982.[36] Along with declining company numbers, there is increasing consolidation of sales and assets among fewer and fewer firms. In 1987, the top 200 firms (representing only 1 per cent of all food processors) owned 88 per cent of all food-processing assets. If present trends continue, by the year 2000 the top 50 will control at least 90 per cent of industry assets.[37]

R&D Investment and Strategies in the Global Sector

Food and beverage companies are rationalizing operations and consolidating through mergers, acquisitions, and joint ventures. But to compete successfully in the global marketplace in the future, they will also have to innovate more effectively and more quickly.

Innovation is an increasingly important source of competitive advantage in the food sector. Because natural growth in food and beverage markets in the developed world is estimated at only about 2 per cent a year, food processors must acquire or create new products if they wish to grow substantially. On the one hand, product innovation in the food and beverage sector is a highly risky enterprise, requiring "deep pockets" and the ability to absorb failures. Indeed, the failure rate for new products is in excess of 90 per cent.[38] The entry costs for some new products in this sector can be extremely high, putting such enterprises beyond the reach of small and medium-sized companies. A recently introduced calorie-free sweetener, for example, took 15 years of development, at a cost of more than U.S.$300 million. One reason for the long development time was the extensive safety testing required to license a new food additive: the submission to Canadian authorities for approval of

this sweetener included 100 separate safety studies and 40 environmental studies.[39] On the other hand, product innovation can be highly rewarding, as the Monsanto example with NutraSweet aspartame in 1988 indicates.[40]

Despite the potential rewards, investment in R&D by food and beverage companies is low compared with that of other manufacturing sectors virtually everywhere in the developed world. For example, in the United States, R&D expenditures in food processing represent just 0.8 per cent of sales and are among the lowest of U.S. manufacturing groups.[41] In line with this relatively low investment, food-processing companies employ relatively few scientists and engineers.[42]

Part of the reason for the food industry's low investment in R&D is its reliance on research undertaken by other industries. Much of the new technology currently in use, for example, has come from outside suppliers. For instance, equipment manufacturers developed automated processing and packaging lines used by food processors, and packaging manufacturers developed a wide variety of the containers and packaging materials used for food applications.[43] In addition, chemical and health care companies have been heavily involved in developing sweeteners. Indeed, only about 50 per cent of the innovations used by food processors are developed by the processors themselves. The remainder come from a wide array of technologically linked industries — machinery, paper, plastics, and so on.[44]

International competitive pressures and strong consumer interest in food quality and safety will accelerate technology adoption. Robotics may find more applications in food-processing plants as operations become automated. Biotechnology will open the way for new food ingredients. It will fundamentally change the food chain, making it possible to design food products throughout the product cycle — from the farm, through the processor, to the retail shelf — and will have a major impact on quality assurance programs, as more rapid detection of harmful organisms becomes possible. In fact, consumer demand for fewer additives in food will likely drive the development of new processing techniques. Information technologies will bring about cost savings through improved processing and inventory control. The need for global marketing intelligence will accelerate adoption of global communication technologies. As we move toward the 21st century, technology will be vital in pursuing new opportunities.[45]

A number of developments in science and technology are expected to have a major impact on the food and beverage industry before the year 2000.[46] They include: aseptic processing and packaging, food irradiation, new packaging materials, advances in nutritional sciences, biotechnology (genetic engineering, tissue culture, fermentation sciences, and so on), membrane technology, and automation and computerization. (See Appendix 1.)

In conclusion, it is apparent that the food industries do have a broad scientific and technological basis. Moreover, significant changes are taking place in science and technology that will have a profound effect on the food industries in future. Food companies must develop, adapt, and adopt the new technologies if they are to compete and win in the global marketplace.[47]

Overview of the Canadian Food and Beverage Sector

The Canadian Sector

The food and beverage sector is a major contributor to the Canadian economy. Larger than the agriculture sector, it constitutes Canada's second largest manufacturing sector. In 1988, the value of its shipments grew by 4.4 per cent to reach $42.5 billion. The sector, characterized by slow but steady growth, is generally recession resistant — after all, people have to eat.

The food and beverage sector employs 250 000 people in more than 4000 plants across the country. In 1988, food products accounted for 84 per cent of the sector's shipments, with the beverage industry accounting for the remaining 16 per cent (Table 3).

Table 3. Food and beverage subsector shipments (1988) (based on total sector shipments of $42.5 billion)

Food and beverage subsectors	Percentage of sector shipments
Meat and poultry	25
Dairy products	18
Beverages	16
Grain-based products	16
Fish	7
Fruits and vegetables	7
Sugar, confectionery	4
Other	7

Source: Industry, Science and Technology Canada, *A Taste of Tomorrow* (Ottawa: Supply and Services Canada, 1990), 3.

The food and beverage sector's importance varies by region. Except for British Columbia, Ontario, and New Brunswick, the sector leads manufacturing output (in terms of dollars) in each province, even topping the petroleum industry in Alberta.[48] The extent of exposure to world market pressures differs according to region and subsector, and there is a tendency for provincial governments to balkanize the national market for many foods and beverages — from eggs to beer. These pressures give rise to many policy dilemmas concerning the most effective way of restructuring the sector.

The annual profit in the food and beverage sector is about 18 per cent, after deductions for wages, energy, raw materials, supplies, and other expenses. The biggest expense — almost 69 per cent of sales — is for materials and supplies.[49]

During the 1980s, there was a gradual increase in the sector's level of investment — from the equivalent of 3.9 per cent of shipments in 1982 to 4.5 per cent of shipments in 1989. In 1988, food and beverage processors spent more than $1 billion on new construction, machinery, and equipment, while total investments, including capital and repair expenditures, approached the $2-billion-dollar mark. Reports of investment intentions indicate that the sector plans to invest slightly more in the future, with new investments likely directed toward modernizing existing facilities and increasing production efficiency. Indeed, the new machinery and equipment component of investment expenditures has increased, whereas the new construction component has decreased.[50]

Overall, the Canadian food and beverage sector is more export-oriented than the American sector. Canada is a net exporter in this sector, with almost 15 per cent of shipments being exported. The United States continues to be Canada's largest trading partner and, as a partner, continues to grow in relative importance. For example, since 1982, the portion of Canadian food and beverage exports destined for the United States has increased from 50 per cent to 60 per cent, while the portion destined for the European Community has decreased from 14 per cent to 10 per cent. Total Canadian food and beverage exports in 1988 were $6.1 billion (Table 4), up from $4.3 billion in 1982. Total imports over the same period increased from $3.5 billion to $5.3 billion.[51] Canada's major exports tend to be commodity items such as frozen fish and fresh pork. It exports few value-added items, the exceptions being frozen French fries, brewery products, and distilled beverages, particularly brands of Canadian whisky.[52]

Table 4. Canadian food and beverage exports (1988)

	Total ($ millions)	U.S. share (%)	Japan's share (%)	EC's* share (%)	Others' share (%)
Food industries (excluding processed fish)	3 046.5	55.7	13.7	8.5	22.1
Processed fish	2 515.7	49.4	23.7	17.6	9.3
Food industries (including processed fish)	5 562.2	52.8	18.2	12.6	16.4
Beverage industries	536.8	85.6	9.9	2.2	2.3

Source: External Affairs and International Trade Canada, *1992 Implications of a Single European Market: Agriculture and Food Products* (Ottawa: Secretary of State for External Affairs, December 1989), 39.

* EC, European Community

Canada's top food and beverage companies, although often diversified concerns, are much smaller than leading European and U.S. companies in the sector. Canada, moreover, has only a few multinational food and beverage companies with global operations, including Canada Packers, George Weston, McCain Foods, Seagram, John Labatt, Molson Breweries, and National Sea Products.[53] Eight Canadian firms rank within the top 200 global food companies.[54] (See Table 5 for a list of the top 10 food and beverage companies in Canada.)

The Canadian food and beverage sector is undergoing a restructuring similar to that on the international front; that is, it is consolidating through joint ventures, mergers, and acquisitions. From 1971 to 1986, the number of Canadian firms decreased by almost 40 per cent, whereas the number of workers rose by about 10 per cent.[55] Some subsectors, such as beef processing, have undergone major restructuring in the past decade, and some large processors are now seeking strategic acquisitions to strengthen core operations. Several large multinationals have recently established a strong presence in Canadian food sectors, including Cargill, Central Soya, and Hillsdown Holdings. One of the most notable food-related corporate mergers in Canada was the 1989 Molson-Carling merger of brewing companies.[56]

While there has been a decline in the number of food-processing establishments, there has also been a dramatic increase in their size. Today, there are only half the plants that there were three decades ago. But these plants produce three times the output of 30 years ago. With the dismantling of trade barriers, further consolidation of the food-processing industry in Canada seems likely, especially in subsectors where Canadian processors are generally smaller and less efficient than their U.S. competitors.[57]

Table 5. Top 10 food and beverage companies in Canada (1989)

Company*	Sales (U.S.$ billions)
John Labatt†	4.6
Seagram†	4.1
Maple Leaf Foods‡	2.8
McCain Foods†	1.8
Weston Foods†	1.3
Kraft/General Foods‡	1.3
Molson Breweries†	1.3
Unilever Canada‡	0.85
Nestlé Enterprises‡	0.85
T.C.C. Beverages§	0.77
Total sales	19.67

Source: Canada Consulting Cresap, "Food and Beverages," contract report for the Science Council of Canada, 1991 (unpublished), 18.

* Ranked according to 1989 sales
† Canadian-based multinational
‡ Subsidiary of foreign multinational
§ Bottler of foreign multinational product

Canada's greatest concentrations (in terms of sales of Canadian products) are found in the following subsectors: breweries, where three firms (now two) controlled 97 per cent of sales in 1986; distilleries, where four firms controlled 75 per cent of sales; flour mills, where three firms controlled 75 per cent of sales; wineries, where four firms controlled 70 per cent of sales; oilseed-crushing houses, where eight firms accounted for 100 per cent of sales; and the fruit- and vegetable-processing industry, where five firms controlled 66 per cent of sales. Downstream biscuit manufacture is also highly concentrated.[58]

Overall, the Canadian food and beverage sector faces a number of advantages and disadvantages. Advantages include the availability of high-quality raw materials from an efficient and relatively diversified agriculture sector; cheap and abundant materials from the fishery sector; proximity to the large U.S. market; a sophisticated and diversified domestic market; a relatively clean environment supporting food safety; and a skilled workforce. One of the main disadvantages affecting much of this sector is the Canadian climate and its impact on productivity, costs, and the seasonal availability of raw materials. Another is the general lack of scientific and technical expertise in Canadian management. A third is the relatively limited market identification of Canadian products.

R&D Investment and Strategies in the Canadian Sector

The food and beverage sector faces an era of increasingly competitive international markets and more demanding consumers. Consumers in Canada and in the world markets served by Canada's food sector are increasingly emphasizing food safety, good nutrition, product diversity, and environmental sensitivity. Competition to meet these demands is intense. Research and development are of central importance in an effective response to the new competitive environment.[59]

Current R&D Investment

The Canadian sector has not been characterized by rapid and significant technological innovation. Time gaps between major innovations in the sector have been long, and change has come in small, incremental steps. According to a report published by the Ontario Premier's Council, both the pace of change and the level of technological innovation in the Canadian food-processing industry are low, lagging well behind those of other industries.[60]

In 1988, real Canadian R&D expenditures in the sector were essentially the same as those of the early 1980s — $55 million in 1980 and $57 million in 1988, in 1981 constant dollars ($78 million in 1988 in current dollars).[61] This is 0.2 per cent of total sales in the sector. Despite a few large indigenous companies, among those firms that do perform R&D the Canadian food and beverage sector invests in research at less than half the U.S. rate (see Table 6). Indeed, Canada trails most developed countries in terms of R&D as a percentage of sales in the sector.[62]

Table 6. Self-funded R&D expenditures of companies in the United States and Canada as a percentage of sales (1988) (R&D performers only)

Company	R&D expenditures as percentage of sales
Foreign-controlled in Canada	0.6
Canadian-controlled in Canada	0.2
Total located in Canada ($78 million on R&D)	0.4
Total located in United States ($1.5 billion on R&D)	0.8

Source: Canada Consulting Cresap, "Food and Beverages," contract report for Science Council of Canada, 1991 (unpublished), 40.

The Canadian food and beverage sector is one of the few in Canada in which foreign subsidiaries are relatively more R&D-intensive than Canadian-controlled firms.[63] Moreover, the private sector accounts for only 8 per cent of Canada's agri-food research spending, significantly less than in most other industrialized nations.[64]

It can be argued, however, that because the Canadian agri-food sector has a large proportion of commodity-based companies, a lower rate of R&D as a percentage of sales is acceptable. Furthermore, in general, R&D efforts in Canada are focused on farm production — the front end of the food chain, where the payoffs are much longer in coming — rather than on food processing. This situation does not augur well, however, in an era of increasing specialty markets driven by customer preferences.

With regard to farm production, research is conducted primarily by government agencies, including provincial and federal departments of fisheries and agriculture. In addition, certain private Canadian food and beverage companies — National Sea Products (scallop aquaculture), Allelix (hybrid

seeds), and John Labatt (yeast fermentation) — are also involved in some production research. Food processing, on the other hand, tends to be concentrated in foreign, particularly U.S.-based, multinationals that do worldwide product development for global brands. The Canadian-based branches of U.S. multinationals tend to rely on central R&D facilities in the United States, institutions that focus primarily on new product development and rapid introduction of branded products. Canadian branches do, however, perform some adaptation and adoption of European and Japanese technologies, usually related to processing and manufacturing equipment.[65] In addition, Canadian food and beverage companies perform primarily commodity-oriented research in areas such as meat, barley, and fish.[66]

Food processing receives less than 10 per cent of Canada's agri-food R&D budget, although sales in food processing are greater than those in primary agricultural production. In 1985, the Nielsen Ministerial Task Force pointed out this anomaly, noting that "there is too much emphasis on efforts to support production improvement 'on the farm', versus 'after the farm gate' value-added food materials and processes."[67]

Current R&D Strategies

By and large, Canadian food and beverage companies follow an "adopt and adapt" R&D strategy (see Appendix 2 for details concerning technology strategy framework and definitions). Because Canadian firms, even the larger concerns, tend to have limited R&D resources, they focus on selective new product development. A few large firms have separate R&D groups working on more innovative technologies, but the overall commitment in these areas is small. However, some notable R&D is being done among the subsectors: by brewers in the areas of microbiology and biotechnology (important developments have emerged, including yeast strains to produce low-calorie beers); by soft-drink manufacturers in the area of environmental waste management; and by suppliers of primary ingredients.

Several factors contribute to Canada's relatively poor innovation performance in the food and beverage sector. First, because of the branch-plant structure of the food and beverage industry, much of the R&D is conducted at company offices in the United States.[68] Second, much of the innovation is by third-party equipment suppliers, who usually offer the technology to any buyer. Accordingly, the advantages of "buying" outweigh the benefits of "making" a technology. Third, virtually all the equipment and machinery used in the industry — for example, extrusion machines, hyper presses, new roasters, and automated stock lines — is developed in the United States, Europe, and Japan. These advances tend to be introduced into the "home" market first.

What food and beverage R&D there is in Canada is undertaken by the private sector, federal and provincial governments, and certain universities. The contribution of each is outlined in the following sections.

Private Sector R&D

A Canadian Agricultural Research Council (CARC) survey shows that Canada's private sector research is highly concentrated, with 80 per cent attributable to 15 major companies. It also shows that private sector R&D expenditures represent only 0.1 to 0.2 per cent of industry sales — a much lower figure than the manufacturing industry's average of 0.7 per cent. In addition, very few small to medium-sized companies have any R&D capabilities. (For more details concerning the R&D and technology strategies of some of the major Canadian food and beverage companies, see Appendix 3.)

Undoubtedly, few companies can afford to tie up the financial and human resources required to pursue applied, let alone basic, R&D. They leave most research to the main research facilities of multinational firms, focusing instead on developing applications for the new ingredients, additives, and processing technologies developed elsewhere.[69]

There are, however, some notable exceptions. For example, although Ault Foods, the dairy subsidiary of Labatt, could have purchased or licensed competing low-fat butters, it chose instead to develop its own product; in early 1988, it introduced Pure and Simple, which became an overnight sensation within the dairy industry. Unlike competing products, Pure and Simple achieves a 50-per-cent fat reduction without gums, stabilizers, gelatins, or other additives and preservatives; its only ingredients are cream and salt. Labatt has applied to patent its unique processing technology in Canada, the United States, and overseas.[70] A few years later, in 1991, Ault introduced Dairylight, an ingredient with no additives or preservatives, that drastically reduces calories and cholesterol in dairy products.[71] Ault developed this milk-based fat replacement with an R&D investment of about $5 million.

Nevertheless, the normal R&D role for food processors in Canada is to adapt products developed at company headquarters to the Canadian market. For example, Nestlé developed its microwaveable sandwich line (Handwich) at its world headquarters in Switzerland, but Nestlé Canada's R&D group replaced the original Swiss cheese with cheddar for the Canadian market, and consumer acceptance improved markedly.[72] Having one central R&D facility for basic research is cost efficient. It seems likely, therefore, that one of the most effective ways of increasing food-processing R&D in Canada would be to create conditions that would induce multinational firms to establish headquarters in this country.

Government and University R&D

In 1988-89, public sector funds invested in agri-food R&D topped $580 million. By far the largest share of this amount, however, was invested in primary production research by Agriculture Canada.[73] According to a study conducted by the Food Network, total food-processing research funding in 1988-89, excluding in-house industry R&D, came to only $18.2 million, of which over $8 million was federal funding.[74] (See Appendix 4.)

Canada has a number of publicly funded federal and provincial agri-food research establishments throughout the country. In British Columbia, for example, there are two Agriculture Canada research stations (one in Agassiz, the other in Summerland), in addition to the B.C. Research Corporation in Vancouver. The Agriculture Canada research station situated in Lacombe, Alberta, supplements three other institutes in that province: Alberta Special Crops and Horticultural Research Centre, in Brooks; Alberta Agriculture Food Laboratory Services Branch, in Edmonton; and Alberta Food Processing Development Centre, in Leduc. Both of Saskatchewan's institutes — the Agriculture Canada Health of Animals Laboratory and the POS (protein, oilseed, starch) Pilot Plant — are located in Saskatoon. Like British Columbia, Manitoba has two Agriculture Canada research stations — one in Morden, the other in Winnipeg — in addition to the Winnipeg-based Manitoba Research Council. In Ontario R&D is carried out at the Agriculture Canada Centre for Food and Animal Research, Ottawa. In Quebec, two research centres are in operation: Station de recherche d'agriculture Canada in Saint-Jean-sur-Richelieu, and Centre de recherche et de réveloppement sur les aliments (CRASH), in Saint-Hyacinthe. As for the Atlantic provinces, the Prince Edward Island Food Technology Centre operates out of Charlottetown, and Agriculture Canada Health of Animals is based in Sackville, Nova Scotia.

Canada has a number of university agri-food research establishments, including: Memorial University of Newfoundland (St. John's), Technical University of Nova Scotia (Halifax), Acadia University (Wolfville, Nova Scotia), Université Laval (Sainte-Foy), Macdonald College, McGill University (Montréal), University of Toronto (Toronto), University of Guelph (Guelph, Ontario), University of Manitoba (Winnipeg), University of Saskatchewan (Saskatoon), University of Alberta (Edmonton), and University of British Columbia (Vancouver).

In an effort to provide information that is of value to the food industry, but is otherwise unavailable, Agriculture Canada has developed a database called FIND (Food Industry).

Future Strategies: Cooperative R&D

At a March 1991 Science Council workshop held in Toronto with representatives of Canada's food and beverage sector, the industry members lamented the "unproductive, duplicative, and wasteful" competition among provincial and federal agencies in food-related R&D. Industry representatives argued that companies, particularly the many smaller companies, do not use federal and provincial government research facilities to their greatest advantage. But they noted that these facilities are inconveniently located for many food processors, insufficiently well advertised, or simply too intimidating to approach (especially as the heads of most food-processing companies do not have science degrees). The workshop participants also underscored the need to encourage cross-Canada cooperation for optimal use of the limited resource base, agreeing that economically beneficial cooperation could be realized through networks involving academic, government, and industrial resources. They recommended, as well, that the top priority in cooperative research be given to assessing the biochemical composition and biophysical properties of Canadian agricultural crops, the objective being to discover new, expanded, and more profitable applications, not only in food and feed, but also in pharmaceutical and other products.

But collaboration is not entirely unknown in the food-processing sector. National Sea Products' scallop aquaculture project — that rare example of good collaboration within the innovation infrastructure — entailed cooperation between Fisheries Resource Development, the R&D arm of National Sea Products of Nova Scotia, the provincial and federal government agencies, and the university community. Partners included the Department of Fisheries and Oceans; the Industrial Research Assistance Program of the National Research Council of Canada; the Natural Sciences and Engineering Research Council of Canada (through its support for a chair in oceanography); Dalhousie University; the Nova Scotia Research Foundation; the Atlantic Canada Opportunities Agency; and the Open Ocean Production Enhancement Network, one of the centres of excellence sponsored by the federal government.

Several formal networks dedicated to agri-food research have been formed in recent years and have subsequently amalgamated. The first of these formal networks, the Food Network centred at the University of Guelph, is concerned with food processing rather than agricultural production. The Food Network now comprises all the key players of Canadian food processing, including the federal and several provincial agriculture ministries, all Canadian universities with food-processing research capabilities, and leading food processors. Its resources include 200 public sector food researchers. In general, the Food Network seeks to inform government decision makers, food industry executives, and media representatives of the important research issues challenging the sector's competitiveness. It helps to link various agencies' research capabilities, to focus interdisciplinary and intersectoral research activity on the needs of the food-processing sector, to develop strategic initiatives, and to facilitate proprietary research arrangements throughout Canada. It will benefit the sector by minimizing the resources required for, and aiding in the creation of, research teams. After much consultation the Food Network has identified six broad strategic research areas: food materials science; food engineering and advanced process control; food biotechnology/processing aids and special ingredients; food safety; food packaging and preservation; and probiotic foods.

In the spring of 1991, Canadian agri-food industry leaders, representing producers, processors, and related sectors, initiated another R&D consortium — the International Centre for Agricultural Science and Technology (ICAST), now also a part of the Food Network. Headquartered in Saskatoon, ICAST's role is to initiate, support, and coordinate agricultural research that results in value-added products and processes, improved productivity, and greater market penetration. ICAST is using a comprehensive approach that connects every link in the agri-food chain, from soil experts to consumer suppliers. It has secured $11 million in seed funding from the federal and Saskatchewan governments, in addition to private sector commitments totalling roughly $2 million.

A third networking effort, also now a part of the Food Network, is the B.C. Food Technology Centre (BCFTC). Formed in May 1988, when the University of British Columbia (UBC)'s Department of Food Science teamed up with the private sector B.C. Research Corporation, the centre's mandate is to provide contract research for both public and private sectors on a project basis. An emphasis is placed on development of marketable products and packaging, toxicology and safety, and waste utilization and treatment. As part of B.C. Research's 13 000-square-metre complex, the BCFTC has about a dozen senior scientific staff, an equal number of technical and support staff, and a pilot plant to prepare, package, and test food products. For extra muscle, the centre can tap into 12 faculty members at the UBC Department of Food Science, the department's 30 or so graduate and postgraduate students, as well as UBC's own recently consolidated laboratories and $1 million worth of specialized equipment.

Competitiveness of the Canadian Food and Beverage Sector

The move toward globalization has forced Canada's food and beverage sector to take a searching look at itself. Canada has a long history of protecting its domestic industry and of managing its supply of certain commodities with prices and import quotas designed to stabilize markets and support farmers' incomes. The upshot was higher prices for Canadian food companies conducting business in the isolated Canadian market. With limited horizons, these companies simply grew accustomed to higher prices and, for the most part, became complacent.[75]

But while Canada looked inward, the rest of the world was moving on, and quickly. Technological advances helped countries that imported food (especially grain) to improve their domestic production capabilities and to produce more. Others who were once merely self-sufficient became exporters.[76] On the home front, competition began to force prices down; federal and provincial governments dipped further into their coffers to support the sagging farm economy; and trade barriers were erected to stop the entry of competing foreign goods. The deteriorating farm economy became a top agenda item at the international round table discussions on the General Agreement on Tariffs and Trade (GATT), where governments from around the globe meet to solve complicated trade issues.[77]

The magnitude of the trade war was highlighted in Canada when the United States started erecting barriers against imports of Canadian food capable of competing in some U.S. niche markets. Following fruitless legal and political battles, an attempt to open the borders was made in 1989 with the Canada-U.S. Free Trade Agreement. During the course of a 10-year phase-in, the agreement is supposed to remove trade barriers, promote freer movement of goods between the two countries, and generate a new entrepreneurial mood in Canada.[78]

But in certain food and beverage subsectors some companies — particularly multinationals — argue that the Canada-U.S. Free Trade Agreement is pointless if they must continue paying the made-in-Canada prices for Canadian commodities, such as milk and poultry. And that, say the companies, is the main issue in Canada's food business. They claim that they cannot compete against U.S. producers if they cannot get raw materials for an equivalent price.[79]

The complex interactions among Canada's supply-management system, the Canada-U.S. Free Trade Agreement, and the GATT, and their effects on Canadian competitiveness in the food and beverage industry, are worth examining in some detail.

Supply Management and Input Costs

National supply-management programs are currently in place for milk, eggs, chickens, turkeys, and broiler hatching eggs. The programs are not unconstrained monopolies; rather they seek to ensure

adequate supplies to Canada's domestic market through production or imports. Prices are usually tied to costs of production or are established by committee. To ensure an effective supply-managed system within the Canadian market, import controls are applied on a variety of dairy and poultry products under the *Export and Import Permits Act*, in accordance with the exception provided for under GATT. As well, tariffs are currently in effect on imports, especially on a number of highly processed products such as chicken dinners and frozen pizza. It is expected that the Free Trade Agreement will bring about the gradual elimination of these tariffs between Canada and the United States.[80]

In addition to federal supply-management systems, there is a whole raft of provincial marketing agencies, as well as legislation, that creates trade barriers between Canada and other countries and between provinces within Canada. Virtually all agricultural commodities in Canada enjoy some sort of price support, subsidy, or import control, either directly or indirectly.[81] Supply-managed commodities are important to the overall farm economy, representing 21 per cent of farm cash receipts.[82]

The farm prices of basic supply-managed commodities are set by provincial marketing boards or federal agencies, depending on the commodity, based on cost-of-production surveys. To date, these prices have been higher than many international prices. Higher prices lead to somewhat lower domestic consumption and, potentially, to problems in protecting the sector against competition from unregulated product and commodity imports.[83]

It is not always supply management or provincial marketing boards that affect Canadian input costs. In some cases, tomatoes for instance, higher input costs reflect climatic conditions or other production inefficiencies, rather than supply management. Table 7 indicates the extent to which, in 1986, some representative raw material inputs to processed foods were priced higher in Canada than in the United States. More recent figures compiled for the Canadian International Trade Tribunal on comparative costs of raw fruits and vegetables indicate that, in many cases, Canadian processors had a disadvantage of 25 to 45 per cent in 1990. The protection from lower-priced imports given to Canadian farmers has already hurt some Canadian food processors, and as tariffs on processed foods evaporate under freer trade, that protection has the potential to damage many more.

Table 7. Key input cost comparisons, Canada-United States (1986)

Product	Key raw material inputs	Ontario cost*	U.S. cost*	Differential: Ontario vs. U.S. (%)
Frozen chicken	Broiler	50.0¢/lb	35.7¢/lb	+40
Turkey pie	Turkey	65.0¢/lb	34.4¢/lb	+88
Tomato soup	Tomatoes	6.0¢/lb	4.8¢/lb	+25
Cottage cheese	Milk (class 3)	44.2¢/hL	28.5¢/hL	+55

Source: Canada Consulting Cresap, "Food and Beverages," contract report for Science Council of Canada, 1991 (unpublished), 20.

* In Canadian currency

The biscuit category provides a good example of the import threat that relatively high input costs pose to Canadian manufacturers. The volume of biscuits imported into Canada has grown at a

cumulative annual rate of 13 per cent since 1980 — despite flat overall retail sales volumes. Annual imported tonnage has more than tripled since 1980 — from 9.7 million kilograms in 1980 to 29.5 million kilograms in 1989 — and now represents over 20 per cent of Canadian consumption.[84]

The growth of biscuit imports is largely attributable to quality differences and cost advantages that translate into lower consumer prices. Factors in lower import costs and consumer prices include:[85]

- Lower tariffs: between 1983 and 1987, biscuit tariffs fell from 7.5 per cent to 5.0 per cent; they are expected to disappear completely (with the United States) under the Canada-U.S. Free Trade Agreement.

- Scale advantages: some importers (predominantly U.S. firms, but also some U.K. and Danish firms) have significant scale advantages — up to 25 times for large U.S. factories — compared with Canadian manufacturers.

- Wheat prices: the price of wheat has been by far the single most important factor fueling import growth and impairing the competitiveness of Canadian-based plants; it drives flour costs and contributes 25 to 30 per cent of the cost of raw materials.

The St. Lawrence Starch Co. Ltd. of Mississauga, Ontario, provides another example of the harmful effect that government protection of higher Canadian commodity prices can have on the food-processing industry. St. Lawrence Starch, a purveyor of corn starch, corn oil, and Beehive corn syrup, was established in 1889. Recently, the Mississauga plant closed, 230 jobs were lost, and production moved to the United States, where St. Lawrence's brands are now made by A.E. Staley Mfg. Co. of Decatur, Illinois. According to Ian Gray, fourth-generation president of the family-owned firm, the immediate cause was a 1986 countervailing duty imposed by Ottawa on U.S. corn after Canadian growers argued that U.S. growers were selling below the cost of production. The duty amounted to 46¢ per bushel by February 1988 and raised the cost of St. Lawrence's raw materials by more than $2.5 million annually. St. Lawrence could not pass along those extra costs to customers, because its U.S. rivals could bring in products extracted from cheaper U.S. corn.[86] (The corn-countervailing duty expired in July 1991.) According to Gray, "That duty was extraordinarily short-sighted. It didn't solve anything for anybody. We used to buy six million bushels a year in Ontario. Now A.E. Staley buys in the U.S. and we sell the product."[87] Gray notes that he warned Ottawa that the duty would mean lost jobs and that agricultural policy should serve Canadians who toil in food plants, as well as farmers. "The country," says Gray, "hasn't wakened to the fact that we compete in a global economy. We have to learn quickly."[88]

Not surprisingly, food processors and the Grocery Products Manufacturers of Canada (GPMC), an advocacy group for the grocery-manufacturing industry, are also campaigning for lower raw product prices, prices consistent with those in the United States. They claim that some prices are 40 per cent cheaper south of the border.[89] According to GPMC president George Fleischmann, "We're into a situation where the lowest-cost producer gets the job. Canadian materials can't be priced appreciably higher than they are in the rest of the world. Our industry's fate hinges to a great extent on what we can do to change this."[90]

Adds Jim Gordon, director of R&D for J.M. Schneider Inc.: "If we can equalize conditions, we have a chance, but if we don't, the U.S. will pick us apart. I'm afraid it will be a one-way road to despair."[91]

Not surprisingly, farmers' advocacy groups, the marketing boards, and the associated farm agencies view the situation in an entirely different light. For example, Gerry Gartner, general manager

of the Canadian Egg Marketing Agency, thinks the pricing issue is a red herring. "Being competitive means much more than decreasing the price of raw materials," he says. "There's a whole gamut of things to consider, including tax policy, economies of scale, and productivity."[92]

Similarly, Ken Crawford, executive director of the Canadian Turkey Marketing Agency, argues that the flaw in the criticism of current supply-management practices is the assumption that processors are running their operations as efficiently as possible.[93] "Producers could give away their products for free," says Crawford, "and you'd still hear the same complaints about supply management, even though some processors are paying more than 25 per cent of their product cost for packaging. How's a farmer supposed to alleviate that?"[94]

Moreover, some analysts of the Canadian poultry industry strongly suggest that the biggest single reason for higher consumer prices for chicken in Canada is higher Canadian retail margins. They argue that there has been a concentration of economic power in the retail sector that is linked to price inflation in commodities in Canada, regardless of whether they are supply managed.[95] There is some justification, they say, for the arguments advanced by producers and marketing boards that the competitiveness problems of the food-processing industry stem as much from the industry's own inefficiency and low productivity as from high agricultural commodity prices.

The recent analysis of the international competitiveness of the Canadian food-processing industry done by Professor Larry Martin and colleagues at the University of Guelph is central to this discussion. Their detailed quantitative analysis — based on several key variables, including the industry's value-added contribution per dollar of its sales, per production worker, as a percentage of its expenditures on production wages, and per plant — provides some evidence that "Canada's food industry is less competitive than its U.S. counterpart, that Canada's disadvantage is increasing, and that this is due to the methods with which labour and capital are combined in Canada compared to the U.S."[96] In other words, Martin's group claims that the productivity of Canada's food-processing industry is not growing as fast as that of its U.S. competitors and that a lack of capital productivity is responsible, at least in part, for this slower growth.

Martin's explanation for the poor competitive performance of the Canadian food-processing sector is that the industry has been constructed behind a set of trade barriers roughly equivalent to a 15- to 20-per-cent tariff. As a result, he notes, the industry is characterized by small plants meant to serve the long, slender, sparsely populated corridor that is the Canadian market. Martin predicts that as trade barriers fall under the Free Trade Agreement, the Canadian industry will be forced to restructure to accommodate north-south trade and mass markets.

Support for Martin's point of view comes from David Clark, president of Campbell Soup Company Ltd of Canada. Clark says that the new era of competitiveness is forcing processors to streamline their operations. He explains that his Toronto plant is constantly under the microscope of newly created worker-driven management teams that have formed within the company to increase efficiency. According to Clark, before the management teams kicked in, the cost of production at his plant was 40 per cent higher than at U.S. plants. "We've narrowed the gap by two-thirds," he says. "We're confident we'll close it the rest of the way in the next 18 months."[97]

If food processors need to consolidate and rationalize operations, they also need commodity prices that are internationally competitive. It is simply unreasonable to expect Canadian food processors to compete in the global marketplace with the handicap of higher agricultural commodity prices.

In fact, the industry members at the March 1991 Science Council-sponsored food and beverage sector workshop unanimously condemned Canada's supply-management system. They see supply management as a recipe for entrenching inefficiency and stifling innovation. From their perspective, the marketing boards' pricing policies, which, they claim, make Canadian foods uncompetitive with U.S. processed products, need urgent action if Canada's food processors are to survive. "We're in a

hard race for economic survival," says Clark. "These absurd regulations were established when global or cross-border competition wasn't even thought of. They're unreasonable and they have to go."[98]

In fact, there appears to be widespread agreement with the food processors' criticisms of supply management, even from Agriculture Canada, which, in the past, has been seen to represent primarily the farmers' interests. As the 1989 Agriculture Canada strategy paper *Growing Together* put it, "the [agri-food] industry needs to be increasingly market-oriented. Some government programs may be preventing us from achieving that goal. Developed over many years and for good reasons at the time, they may not all be suitable for the future. Many promote expanded production, without encouraging more aggressive marketing. Others may be keeping processors' costs at artificially high levels."[99]

Canada-U.S. Free Trade Agreement

Given the significant contribution of the agri-food industry to the Canadian economy, it is important to look carefully at how that industry has been, and will be, affected by the Canada-U.S. Free Trade Agreement.

The agreement does not provide for complete "free trade" for most agricultural products. It offers enhanced trade, true, but not a completely unfettered, market-oriented bilateral flow of agricultural products across the border.[100] In particular, it should be noted that the agreement does not address Canada's supply-managed agricultural subsectors, such as dairy and poultry, in a substantial way. Thus, the agreement will require little adjustment to accommodate the primary producers of Canada's supply-managed food and beverage commodities.[101]

During the initial few years of the Free Trade Agreement, Canadian food processors are expected to adjust by replacing aging plants and equipment, and reducing overhead and fixed costs. After this, the key issue will be whether to export from Canadian plants or to convert the plants into warehouses. The answer will undoubtedly depend, to a great extent, on the price of raw food supplies.[102] If Canadian food processors are forced to purchase more expensive inputs from Canadian suppliers, problems may arise for future investment and plant location decisions, especially for larger firms. Companies such as George Weston, Labatt, McCain Foods, and other multinational enterprises may find it more attractive to locate future production in the United States than in Canada.

Several recent reports have confirmed that the Free Trade Agreement poses problems for Canadian food processors. For example, the February 1989 report of the Food Industry Advisory Committee of the Ontario Ministry of Agriculture and Food states that supply-management policies would make it more difficult for food processors to compete under the Canada-U.S. Free Trade Agreement. The report also states that marketing boards serve to stabilize producers' income rather than to achieve competitiveness.[103]

The frozen pizza industry offers one example of the competitive advantages obtained by the U.S. food-processing industry from its lower agricultural input costs. Canada's two largest frozen pizza manufacturers, McCain Foods and Pillsbury Foods, have said that unless they can purchase their cheese requirements at competitive prices, so as to compete on an equal basis with imported frozen pizzas, they will move their production facilities to the United States.[104]

Some 75 per cent of Canada's mozzarella cheese production is utilized by the pizza industry. Therefore, any loss of Canadian frozen pizza processing capability would also have serious implications for the dairy industry. In fact, Loblaw Companies Limited has already introduced a new frozen pizza imported from the United States, which, even including shipping costs, is approximately 5 per cent cheaper than a similar Canadian product. As the tariff decreases, Loblaws will likely increase its line of imported pizzas.[105]

In summary, the Canada-U.S. Free Trade Agreement has laid the foundation for the reforms necessary to achieve a more liberal agricultural trading arrangement. But it is only a start. Many of the more difficult issues relating to agri-food trade still need resolution.

GATT

Countries are allowed, under the General Agreement on Tariffs and Trade (GATT), to limit imports of certain products by putting them on an Import Control List (ICL). Products considered as originating from predominantly one food, rather than a combination of different foods, can be protected under the ICL. For example, to protect the supply-managed dairy industry, Canada bars the importation not only of fluid milk, but also of products made entirely from milk, such as butter. As for other products, foreign producers are allowed to supply only a small portion of Canadian requirements. In 1987, for example, the poultry import quota was 6.5 per cent of domestic consumption; the turkey quota, 3.7 per cent. However, Canada's ICL already contains most of the products that could be allowed under GATT.[106]

Talks aimed at liberalizing the GATT broke down in December of 1990 because of a deadlock between the United States and the European Community over farm subsidies. As of mid-1991, negotiators are continuing the attempt to overcome the deep divisions on farm subsidies that stalled the talks.[107] The nature and extent of the global demand-supply adjustments of the next decade will depend heavily on the outcome of the current Uruguay Round of GATT negotiations. If little progress is made to liberalize world agricultural trade, one can expect to see a continuation of trade-distorting national programs and an international market dominated by many forms of noncommercial forces. These will include continuing border controls and import restrictions, policy-induced surpluses, various forms of subsidized export-enhancement programs, increased public outlays for national farm programs, and greater price instability in the international marketplace. In other words, the 1990s could result in an extended and accentuated version of the agricultural events and issues that characterized much of the 1980s. This is not a pleasant picture to contemplate, but it would be the inevitable result of a global economy based on economic anarchy.[108]

If the basic objectives of the Uruguay Round are realized, however, one can expect an agricultural industry and a trade market more attuned to global demand and supply forces by the end of the century. This is not to suggest that major adjustments can be avoided as the industry moves toward a more market-oriented production, consumption, and trade system. Such structural adjustments will indeed be required to dismantle some of the many trade-distorting and costly agricultural policies and programs developed in previous years. But the ultimate result of adjustments will be a system within which production efficiency and comparative advantage will dictate regional production and trade patterns for agricultural commodities. The drive for national self-sufficiency will be replaced by a greatly enhanced volume of world agricultural trade.[109]

A successful outcome of the multilateral trade negotiations under the GATT should therefore bring about a more open access to world markets, a worldwide reduction of trade-distorting subsidies, and a clearer set of international trade rules for agriculture. These developments would be of significant benefit to the Canadian agri-food sector, which has suffered substantially from international trade wars and protectionism.[110]

Protectionism of another kind has also been rampant in this sector in Canada, this time practised mainly by the provinces with a view to developing their brewing sector. Each province, except for Prince Edward Island, has insisted that the major breweries set up operations on their soil. The provinces maintain discriminatory pricing policies and have also prohibited movement of beer across provincial borders. The end result has been a highly fragmented Canadian beer market, dominated by a few major companies that, compared with U.S. "best practice," run a series of rather inefficient breweries. In 1989, a GATT panel ruled that Canadian trade barriers discriminated against

imported beer, the distribution of which falls under provincial jurisdiction. Since then the federal government has worked with the provinces in an attempt to dismantle these interprovincial trade barriers, to satisfy the GATT panel, and to contribute to a major overhaul of Canadian brewing. The reduction in trade barriers should promote domestic and international competition and contribute to a rationalization of this subsector; that might, in turn, lead to plant closures, and not so much to bigger breweries as perhaps to longer production runs of different brands in different markets.

Canadian Competition Policy

In addition to the Canadian supply-management system, another potential impediment to the ability of Canadian food processors to compete globally may be Canadian competition policy. Take, for example, the disintegration of the proposed merger between Canada Packers' Maple Leaf Mills and John Labatt Ltd.'s Ogilvy Mills. It fell apart in April 1991, after the federal Bureau of Competition Policy had opposed the deal, saying it would reduce competition. The new company would have controlled 54 per cent of Canadian flour production. It would also, however, have been one of the top five flour producers in North America, with sufficient clout to compete against large U.S. rivals.[111] Such a concentration of economic power in the flour business would, no doubt, be undesirable if the Canadian market and industry were isolated from international competition. But if Canadian companies are to compete in a North American free trade zone, as well as globally, it seems inappropriate for governments to consider Canada as a separate economic unit when determining competition policy.

Opportunities and Growth Strategies for the Canadian Sector

Even on their own assessment, Canada's food processors are ill prepared to meet global competition. The results of a survey of senior executives of Canada's food-processing companies, published in the magazine *Food in Canada* in 1990, confirmed that Canadian food processors expect to face increased competition, both domestically and globally, throughout the 1990s. However, few believe they are ready for it. Fewer than one-third of respondents rated themselves well prepared for the globalization of trade, while a third rated themselves as poorly, or not at all, prepared.[112]

Despite their lack of preparedness, most respondents had a clear view of what it takes to improve their ability to compete. They perceive R&D and the application of technology as the key determinants of future success. These respondents, from among the more research-intensive companies in the food and beverage sector, expect to increase their investment in R&D from the current level of 1 per cent of sales revenue to 3 per cent over the next five years. For the smaller players, R&D is seen to play a less critical role in enhancing their global competitiveness. Nevertheless, they also intend to increase their investment significantly.[113]

Although the industry may be unprepared, there are still important and potentially beneficial opportunities in the global marketplace for Canada's food and beverage industry. Four markets merit particular attention: the United States, influenced by the Canada-U.S. Free Trade Agreement; Western Europe, with the move to a single European market by 1992; Eastern Europe, with political changes leading to more open markets; and Japan, with its people's growing interest in Western tastes and eating habits.[114]

The United States: Still Canada's Major Market

The United States has traditionally been the major export market for Canadian processed food and beverage products; over the years Canada has also enjoyed a trade surplus with its southern neighbour. More than 60 per cent of the value of Canada's exports of agricultural products, excluding grains and oilseeds, went to the United States during the 1981-87 period.[115] In light of the Canada-U.S. Free

Trade Agreement, Canadian food-processing companies need to re-examine their production and marketing strategies, assess their competitive advantages, and focus their attention on new market opportunities.[116]

The European Community: Site of Renewed Opportunity

Traditionally, Canada has had a trade deficit with the European Community in food and beverages. The European Community purchases approximately 12 per cent of Canada's exports of food and beverages. In 1988, fish and red meat accounted for most of Canada's $700 million in exports to that market. In turn, Canada's imports from the European Community exceeded $1 billion, led by wine, which accounted for almost 23 per cent of the total.[117]

Economic integration of the European Community in 1992 will create new opportunities and challenges for the marketers of food products. Canadian businesses and governments need to examine strategies to establish a presence in Europe. Strategic alliances, production licences, and joint ventures are seen as important mechanisms for gaining an early foothold, especially for small and medium-sized businesses.[118]

Eastern Europe: Challenge of a New Dawn

The move of East Bloc countries to more market-oriented economies will undoubtedly create a range of new opportunities for enterprising food and beverage marketers. Consumer demand for products other than basic food items is largely unsatisfied, and the anticipation of increased prosperity could result in accelerated demand. As East Bloc economies become more buoyant, these countries will emerge as both markets of opportunity and potential competitors.[119]

Japan: A Richer Market

Japan, the world leader in food imports, is Canada's second largest export market. Canadian exports to Japan exceeded $1 billion in 1988, led by red meat and fish products. As well, sales of vegetable oils and frozen fruits and vegetables have been growing. Imports from Japan, limited mostly to fish products not produced in Canada, have been over $50 million annually since 1984.[120]

Consumption trends in Japan are influenced by rising incomes and reflect a shift toward tastes that resemble those of North America more and more closely. Rice consumption, while still significant, has declined by 30 per cent over the past 20 years, and convenience is increasingly a factor. The strong market for luxury goods will continue, because Japanese gift-giving customs are not expected to decline. For all products, Japanese consumers insist on high quality, good presentation, and small packages.[121]

Technology and Innovation Strategies for the Canadian Sector

Research-driven innovation is imperative for Canadian companies jockeying for position in the global food and beverage market. Some of the successful measures that food and beverage companies, large and small, have used to promote innovation within their organizations have been identified by Peat Marwick Stevenson and Kellogg.[122] A summary of those measures follows.

Change the Culture

For companies in the Canadian agri-food business, changing the corporate culture is almost a precondition for bringing about innovation. Such changes take time, leadership, and investment. The process generally starts with a leader who has a clear vision of the desired new culture; that vision is

then shared with, and subscribed to, by all employees. The key is to have a clearly enunciated vision that captures the imagination and a detailed plan with which to realize that vision.

Train and Develop Employees

Innovation will not happen without an investment in training and employee development. One company put every employee through a creative problem-solving course so that, from caretaker to chairman, all would have the skills to look for alternative, creative solutions. This company also involved all its employees in a total quality-management program.

Improve Communication

In many companies, the steps taken to improve communication within the company, and between that company and its customers, have greatly helped to promote innovation. Improved communication often starts with a clear statement of the company's mission and goals. It includes discussing planned changes with employees and unions and getting their input and ideas for improvement. It means using company magazines, multidisciplinary task forces, and customer service teams to facilitate communication between departments, divisions, and plants.

Flatten or Decentralize the Organization

Companies have found that flattening or decentralizing their organizational structure (and at times doing both) will spur innovative change. Two Canadian agri-business companies, for example, reduced the number of middle managers and supervisors within their organizations, replacing them with self-directed teams. This shortening of the lines of communication encouraged employees to make more decisions and to innovate on the factory floor.

Another company operates only a skeletal head office and delegates as much decision making and innovation as possible to the plant level. This same company finds that encouraging a healthy level of competition between its plants produces minor, but continuous, innovation.

Recognize and Reward Innovation

Two companies in particular have found that a modest, low-cost awards/recognition program can help to promote innovation. In their new programs, a substantial share of the first year's savings is given to the "team" or individual that suggests the best innovation.

Form Multidisciplinary Teams

Barriers between departments can often hinder innovation. Three Canadian companies now use multidisciplinary teams to break down barriers and to promote innovation.

Establish a Technology Watch

Maintaining close contact with evolving technologies and techniques in other industries and countries is seen as a primary means of promoting innovation. Such activity involves regular visits to other countries and close monitoring of relevant industry publications.

Exchange Technologies

Through technology-exchange agreements with companies outside Canada, some Canadian companies ensure their technology remains on a par with, or even surpasses, the best in the world.

Develop a Customer Focus
Getting the whole company, rather than just the sales team, to focus on customers permits everyone to understand and serve customers better. This orientation often leads to innovative, customer-tailored products and services that give the company a competitive advantage.

Encourage Risk Taking
One of the most important steps a company can take when promoting innovation is to encourage risk taking and be willing and able to absorb the costs of failure.

Food Sector Recommendations for Government Policies and Actions to Promote Innovation

From a survey of Canada's food-processing companies it is clear that the senior executives believe that governments at all levels are seriously undermining their ability to innovate and compete. They particularly oppose governments' maintenance of supply-managed commodities, as well as the Bank of Canada's high interest rate policy and its corollary, a high Canadian dollar. In 1990, senior executives in Canada's food and beverage sector endorsed the following key policy recommendations regarding innovation.[123]

Less Is More
Both manufacturers and distributors strongly agreed that, overall, government should play a very limited role in bringing about innovation in the agri-food industry. Most believe that government involvement only adds a degree of inflexibility that blocks rather than promotes innovation. Moreover, government is not generally judged to be close enough to, or adequately knowledgeable about, the industry to act as an effective catalyst for innovation.

Coordinate Basic Research
Given the broad level of agreement that the Canadian agri-food industry lacks the critical mass to fund basic research, industry representatives suggested that governments should perhaps help coordinate such research. But governments should not direct research. Their role would be to coordinate and facilitate the efforts of individual companies, in order to avoid duplication and waste.

Helping to create partnerships between the industry and academic research institutes could be a key part of this coordinating role, said the respondents. Helping the industry to develop a clear overall research strategy and priorities might also be involved. Japan's Ministry of International Trade and Industry (MITI) was suggested as a possible model for Canadian government involvement in promoting innovation.

Inform and Educate
Many respondents felt that a credible role for government in promoting innovation would be to provide information and education on the subject — moving from the basics of what innovation is, through to the structural and process changes that can promote successful innovation.

An important element of the government's role would be to publicize examples of successful innovation within the industry, thus helping everyone to learn from the positive experiences of others. Such an undertaking would also help offset the tendency for failures and plant closures — that is, for "bad news" — to dominate media coverage of the industry.

Reduce Legislation

There was virtually unanimous agreement among senior executives that the agri-food business is encumbered with too much legislation. Areas of particular concern are packaging and environmental legislation; food safety; and, especially, clearance of new products, ingredients, and processes. It was suggested that the federal government should be more willing to approve new products and ingredients that have had government approval in other countries, particularly in Europe.

Invest in Human Capital through Training and Development

Respondents identified postsecondary training and development as a significant and legitimate area for enhanced government involvement. Most respondents cited the inadequate pools of trained and skilled labour, especially engineers, as a significant constraint to Canada's competitiveness. (This is the case despite the fact that Canada spends more on primary and secondary education than any other G-7 country.) They said the appropriate role for government might be to promote, or provide incentives for, more "on-the-job" training aimed at developing industry-specific skills. The latest available data (1987) indicate that Canadian companies invest a meagre 0.6 per cent of their payroll in employee training — roughly half the U.S. level and less than one-eighth the German level.

Conclusion

The Canadian food and beverage sector is large and covers a broad range of subsectors while retaining a relatively strong local-market orientation. Some subsectors, such as fish processing, have commercial advantages because of sophisticated processing and competitive material inputs. Others, such as dairy and poultry processing, face significant handicaps because of high agricultural input prices. The food and beverage sector is generally not as cost-competitive as its major competitor, the United States, leading to serious problems now that the impact of the Free Trade Agreement is beginning to be felt. The sector as a whole is also lacking in R&D and is relatively weak in technological innovation. In general, the large Canadian food and beverage firms adopt and adapt product and process technologies developed elsewhere but make negligible R&D expenditures.

The sector's competitiveness appears constrained by the lack of sufficient vision and commitment on the part of the private sector. Specifically, the private sector is not seeking out technological opportunities, particularly with regard to establishing partnerships and collaborative R&D with universities and governments designed to build globally competitive companies able to stimulate the market growth that is so vitally linked to spending on R&D. But establishing partnerships is only a partial answer to the problem, for such partnerships primarily help during the initial research and early development phase of technological innovation. It is the business and financial risk taking required to scale up developments to commercial operations and to continue long-term improvements when return on investment is uncertain that constitutes the major block to effectively using innovative technology.

Although domestic R&D-based innovation has not been a prime factor in determining past competitiveness in Canada's large food and beverage sector, there are opportunities warranting increased R&D activity, and a few firms have made serious R&D expenditures. More, however, will likely need to do so if the sector as a whole is to respond satisfactorily to the challenges of the Free Trade Agreement, the ongoing shifts in consumer preferences, and technological change. Collaborative R&D programs, with Agriculture Canada centrally involved, will also be critical in the shaping of a more sustainable agri-food system in Canada.

Each of the four major Canadian performers of food R&D in 1980 — General Foods, Canada Packers, John Labatt, and George Weston — has greatly reduced R&D staff in the last decade. In large part, these major companies have focused their business strategies on their core businesses rather than on new areas, with each trying to achieve the top or second market position in major product categories.

It is clear that an overriding concern among members of the food and beverage sector is too much government "interference" through taxes, subsidies, programs, policies, and, above all, through Canada's supply-management system for agricultural commodities. It is less clear that the sector is really encumbered with too much legislation at a time when the public is deeply concerned about food safety and environmental issues. However, members of the sector believe that they have the capability of competing and winning with innovative products and processes in the global marketplace, so long as governments do not force them to operate with one hand tied behind their back through, for example, higher commodity prices, higher taxes, and higher interest rates than their competitors must pay.

The Canadian agri-food sector remains skewed toward raw materials and the production and export of commodities. Almost 75 per cent of Canada's total agri-food exports still come from trade in cereals, oilseeds, and meat products in either raw or partly processed forms; products that are processed further represent a very small part of Canadian agri-food exports.[124] This lack of differentiated product brand names is a serious weakness for the future development of the Canadian

industry. Besides doing more R&D, the Canadian sector would have to make stronger identifiable marketing investments if it is to move toward more processed products.

Value-added exports tend to generate much greater economic activity for the exporting country than do commodity exports — more jobs, more taxes, higher profits, and so on. For example, the U.S. Foreign Agricultural Service estimates that, at least in theory, whereas every dollar of wheat grain exported generates only U.S.$5.50 of business activities and U.S.$1.50 in payrolls, one dollar of exported wheat flour more than doubles these benefits, generating U.S.$14 in business activities and U.S.$3.50 in payrolls.[125] However, most U.S. flour exports are heavily subsidized, which may distort such calculations.

But the tendency in Canada is to export agricultural commodities and import processed goods, rather than adding value. In other words, Canada is exporting the more skilled and high-paying jobs, the corporate profits, and the taxes that accrue to value-added sectors in today's knowledge-intensive global economy. This situation is not unusual. It happens in several other Canadian sectors as well. What is unusual is the high degree to which government policy and practice still reinforce this situation in the food and beverage sector.

Canadian governments have traditionally protected farmers' incomes by managing agricultural commodity supply and imposing prices and tariffs. However, there is a widespread perception in the private sector that at least some parts of the Canadian food-processing sector suffer from high input costs because of the country's supply-management system. With the dismantling of trade barriers and the arrival of competition on a global scale, these high input costs threaten to lessen the competitiveness of certain subsectors of the Canadian food and beverage sector, to close Canadian processing plants, and to throw Canadian workers out of jobs.

If this sector is to enhance its performance, Canadian governments must ensure that their policies and practices respond to a broad set of goals. This is an era in which many food companies are targeting smaller market niches and pursuing a strategy that requires more careful product development and marketing. As well, the farming community faces increasing pressure to produce safe and nutritious food in a manner that achieves environmental sustainability. This places the onus on governments to develop an integrated agri-food policy that provides a more holistic perspective for the direction of R&D resource allocation rather than one driven by a simple, short-term focus on responsiveness to market forces or by lowest-cost competitiveness without regard for environmental and social costs. It also places the onus on firms — and some have already responded well — to give serious attention to environmental concerns, perhaps by forming environmental task forces or commissioning environmental audits, thereby helping to breed efficiency levels and standards of excellence for which they can take pride.[126]

One overriding goal is to improve the food and beverage sector's innovative capability. The fact that government, university, and private sector research enterprises have already helped to put this sector's house in order, through cooperation and coordination in the Food Network, is a very encouraging development. A much improved rationale is now in place for increased government support of private-sector-driven research within the Network. In particular, strategies designed to target niche food markets are still needed — strategies that could help define the requirements for food-processing research and for a more effective integration with agricultural science and technology needs.

To strengthen this sector it is equally essential that Canadian companies enhance and carefully integrate their technical and export marketing capabilities. In the long run, these activities will likely require the expansion or formation of additional multinational firms headquartered in this country.

Canadian food processors need not be forced out of the international market. The challenge is to match their outputs to relevant opportunities within the changing global marketplace.

Appendix 1. Food and Beverage Technologies

A number of science and technology developments are expected to have a major impact on the food and beverage industry before the year 2000:[127]

Aseptic Processing and Packaging[128]

The basic principle involved here is the sealing of a sterile food product in a sterile package (the term "sterile" means that all *Clostridium botulinum* spores have been killed). Applications of this principle range from portion-packed fruit drinks to industrial packs of tomato sauce. Several technical problems must be solved, however, before this technology can be used more generally: the lack of effective methods to sterilize some food products; the lack of aseptic filters suitable for low-acid foods; and limited shelf life of foods in flexible packages.

Food Irradiation[129]

In food irradiation, gamma rays are used to reduce the population of spoilage organisms, kill all non-spore-forming pathogens, or kill all organisms associated with the product. The advantages to irradiation as a food preservation process are that it is a low-temperature process that minimizes changes to the organoleptic properties of food products (that is, flavour, colour, texture, and so on); and that it can be applied flexibly to a variety of food products in a wide range of containers. In summary, it seems to be well adapted to the production of a variety of "shelf-stable" food products. However, although irradiation has benefited from a great deal of R&D, governments have been reluctant to approve its use because of public concerns about radiation.

Irradiation has not been implemented in Canadian processing plants because it is expensive and because many companies fear that consumers will not accept it. Although low-level irradiation has been accepted by the Canadian regulatory bodies and the Consumers Association of Canada, the federal government is still soliciting input from industry representatives and consumers concerning labelling requirements for irradiated food.[130]

New Packaging Materials[131]

Traditional wood, glass, metal, and paper containers are continually being modified, as are new synthetic packaging materials that can be optimized for each food product and its application. Developments in the actual packaging machinery — to speed production, increase package reliability, and reduce costs — are promising as well.

Advances in Nutritional Sciences[132]

Currently, scientific research is advancing our understanding of the relationship between nutrition and health in important ways. When making decisions about food purchases, consumers are increasingly influenced by their perception of a product's nutritional value. The result is an increased demand for food products that meet superior nutritional requirements.

Biotechnology[133]

Modern biotechnology (genetic engineering, tissue culture, fermentation sciences, and so on) holds great promise for the food industry. The possibilities for improving plants and animals and developing microorganisms that can produce desired substances by fermentation are virtually limitless. Further, there is intense R&D activity in the field around the world: dozens of companies and hundreds of academic researchers are engaged in research related to genetic engineering. A 1989 report prepared by the U.S. Food and Drug Administration suggests that biotechnology applications will be a major driving force behind enormous changes in the food industry over the next decade.[134]

Membrane Technology[135]

In the context of the food industries, membrane technology comprises reverse osmosis, ultrafiltration, and microfiltration. All these processes, which depend on membranes with pore sizes that correspond to the size of molecules, are used to concentrate food products and to separate substances at the molecular level. Applications in food processing are most advanced in the dairy industry, where membrane technology is employed, for example, to concentrate milk for use in cheese manufacturing and to concentrate cheese whey. The use of membrane technology in food processing — both to cut costs and to develop new food products — has been expanding rapidly in recent years.

Automation and Computerization ("Lean Production")[136]

The use of computers in controlling inventories, warehouse operations, and distribution systems is already well developed. Controlling food processes by computers becomes more practical every day as advances are made in computer hardware and software. Companies that are able to make effective use of these new tools as they become available will enjoy success. It can be predicted that ultimately a company's survival will depend on being able to obtain the efficiencies and product quality that can be achieved only through improved process control.

Appendix 2. Framework for Technology Strategies

As part of the methodology for analysing each sector, the Science Council of Canada sought whenever possible to assess company technology strategies according to the following framework:

	adopt and adapt	innovation	breakthrough
product			
process			

Strategy Classes

Adopt and Adapt: Acquire a technology and adapt it to serve as a competitive platform.

Innovation: Incrementally improve on winning technology to get greater market share or maintain competitive edge.

Breakthrough: Seek to create a discontinuity in the marketplace, thereby leaping ahead of the competition.

The company case studies generally looked for at least seven key dynamics influencing a company's technology strategy:

- three internal dynamics:
  - competitive position,
  - capacity for innovation, and
  - strategy and vision; and
- four external dynamics:
  - customer demands,
  - competitive rivalry,
  - supply condition, and
  - available technology.

The methodology also incorporated essentially a three-step process for each sector. In the first step one or more contractors analysed the main elements in the competitive and R&D performance of the Canadian sector and its leading foreign competitors. The second step included evaluation of the contract report(s), discussion with contractors and other experts, additional in-house research, and preparation of a draft Council report. In the third step, external reviewers commented on one or more drafts of the Council report, which were then revised and refined as required, drawing on the advice of the liaison person for that sector on the project committee (see Acknowledgements). For some sectors, the third step also involved several external reviewers in a small workshop, one part of which helped

define some elements of a potential action plan for the sector. The report was then submitted for final approval to the Executive Committee of the Science Council, before being forwarded to Industry, Science and Technology Canada.

Appendix 3. Major Canadian Food and Beverage Companies: R&D and Technology Strategies[137]

National Sea Products

National Sea Products of Nova Scotia, one of Canada's largest fish-processing companies, with sales in 1989 of $606 million, operates in many subsegments of the fish-processing industry: fresh, frozen, and salted fish and such seafoods as lobster, herring, halibut, scallop, and cod. The company's major branded products are High Liner in Canada and Booth in the United States.

National Sea views R&D as a "defensive measure," an investment in the future, and has accordingly developed Fisheries Resource Development (FRD) as its R&D arm. Through FRD, National Sea plans to produce higher value-added products and to invest in aquaculture. With 15 employees and a budget of $1.5 million, FRD sees its contacts with universities, the National Research Council of Canada, and other government laboratories as crucial in adding critical mass to a relatively small R&D department.

Unlike most food and beverage companies, FRD puts most of its R&D effort into products and innovations. The company reports that 90 per cent of its R&D is dedicated to innovation and 10 per cent to breakthrough research. That research is divided into three groups: product innovation, process innovation, and resource optimization. Consistent with the mandate of the three groups, FRD:

- seeks to add value to fish commodities through branding of products (High Liner) and increased processing;
- works on ways to increase fish-harvesting and -processing efficiency (for example, FRD was instrumental in convincing fishing fleets to move to containers and self-unloading concepts);
- is developing processing equipment, in conjunction with the Nova Scotia Research Foundation, for scallop aquaculture (technologies for post-harvest production and processing); and
- is engaged in two aquaculture projects: halibut and scallops.

Labatt Brewing Company

Labatt Brewing Company is one of the largest beverage companies in Canada. Labatt brews and markets 38 national brands of beer, including Labatt's Blue, John Labatt Classic, and Carlsberg. Brewing sales in 1990 were $1.9 billion. In addition to its Canadian interests, the company has interests in the United States (Rolling Rock) and Europe (Labatt's Strong Canadian Lager and Birra Moretti).

Labatt Brewing Company has a strong commitment to R&D. Its R&D department has 43 employees and a budget of $3 million (or 0.2 per cent of brewing segment sales). Although Labatt's recently cut 100 salaried positions, its R&D department actually expanded, and a biochemical engineer was hired.

Labatt's R&D strategy reflects a significant innovative component, combined with a policy of adapting and adopting known technology. The company reports that its R&D investment is split half and half between adapting and adopting new products and processes, and innovative research. Much recent R&D work has been focused on developing better products using improved process technology. The company recently completed a $2 million pilot plant that it describes as "the most technologically innovative experimental brewery in the world."

McCain Foods

With worldwide sales of more than $2 billion, McCain Foods is Canada's second largest food company. It operates in the fresh and frozen fruit and vegetable business. McCain Foods is primarily market- rather than technology-driven. McCain Foods' technology strategy is to be an early follower, adapting and adopting new process technology developed elsewhere in order to introduce new branded products. Technology drivers include the desire to capitalize on new product development opportunities, and the need to modernize operations and install labour-saving systems.

McCain Foods, which has had a separate R&D department for 20 years, focuses its R&D entirely on adapting and adopting technology. The majority of its R&D investment goes toward product, as opposed to process, development. Because McCain's is a private company, R&D dollar figures are not available.

Schneider's

With sales in 1989 of $619 million, Schneider's ranks as a mid-sized Canadian food processor. It operates primarily in the meat industry but also in the poultry and cheese segments, and its product portfolio includes several new, higher-value-added products in microwaveable form. Food service is a relatively recent addition to Schneider's business. The company's technology strategy is to develop new products using adapted and adopted technology. Schneider's invested an estimated $1.5 million in R&D in 1989, all of it in adopting and adapting technology developed elsewhere. Some 70 per cent of Schneider's R&D investment was in product development, with the remaining 30 per cent in process technology.

Schneider's recently launched a Just-For-Kids line of products — a first in Canada. The idea for the new line began in 1989, when company executives saw co-extrusion equipment in Europe capable of extruding meat, poultry, and so on in different shapes. Schneider's modified the equipment and spent $750 000 launching the new product line focused on nutritional products that children like to eat.

Weston Foods

Weston Foods is a large Canadian food and beverage processor (see Table A-1).

Table A-1. Profile of Weston Foods (1989)

Products	Sales ($ millions)	Assets ($ millions)	Number of employees
Baking	1 066.00	461.00	8 900
Chocolate, dairy, and specialties	539.00	218.00	2 500
Total	1 605.00	679.00	11 400

Diversified Research, or Weston Research, was established in 1947 as a separate R&D facility of the George Weston Company. The work at Diversified Research reflects a blend of applied research (two-thirds of total), quality-assurance testing, and basic research. With between 80 and 100 scientists

and technical people and 20 support staff, Diversified Research does 75 per cent of its work for Weston's companies, the remainder being outside contract work.

Weston Foods' strategy is to conduct applied research to keep its products competitive; its predominant R&D activity, therefore, is to adapt and adopt technology for new product development. Of Weston Foods and Diversified Research's total R&D spending of $3.2 million, 95 per cent goes to adapting and adopting new technology and 5 per cent to innovation. Some 65 per cent is spent on product development and the remaining 35 per cent is spent on process research.

Canada Packers (now Maple Leaf Foods Inc.)

In the late 1980s, with its R&D adapt and adopt strategy and consistent annual R&D expenditures of more than $7 million (representing more than 9 per cent of total Canadian food and beverage R&D), Canada Packers ranked as Canada's leading R&D spender in the food and beverage sector. However, once it was acquired by British-owned Hillsdown Holdings in 1990, it cut more than 1000 jobs, closed 13 plants, and eliminated the research department. More than half the R&D staff of 30 scientists, engineers, technicians, and support staff were let go, with the remainder absorbed by the operating companies. R&D is now being provided by the holding company.

Lassonde

Although investment by Canadian food processors in R&D is generally low, one exception is the Quebec juice maker Lassonde. Lassonde is the only producer of fresh apple juice in Quebec. It employs 500 people in five plants. Juice accounted for 73 per cent of Lassonde's $96.8 million in 1989 revenues.[138]

With an R&D staff of 20 and R&D expenditures of 2 to 3 per cent of sales, Lassonde is one of those rare Canadian companies that not only develop some of their own technology, but also seek to sell it abroad. For example, it spent $2 million during the late 1970s developing a clarification process for apple juice that does the job in one hour versus the original eight to 10. The company now has a special subsidiary — Lassonde Technology Inc. — that earns several hundred thousand dollars a year selling this and other processes to companies abroad.[139]

Appendix 4. Food Research Funding

Table A-2. Food research funding provided to universities and provincial and federal laboratories from external agencies (1989-1990) (dollars)

	NSERC*	AgCan†	DF&O‡	Federal	Provincial	Industry	Total
Universities							
Acadia Univ. Wolfville, N.S.	129 700	—	—	—	—	9 000	138 700
McGill Univ. Macdonald College Montréal, Que.	356 116	63 000	6 500	108 975	134 873	40 000	709 464
Memorial Univ. St. John's, Nfld.	52 639	—	9 000	135 312	49 980	—	246 931
Technical Univ. of Nova Scotia Halifax, N.S.	568 392	52 807	102 191	210 447	230 040	300 464	1 464 341
Université Laval Ste-Foy, Que.	652 892	136 683	—	204 683	851 612	379 810	2 225 680
Univ. Alberta Edmonton, Alta.	123 679	—	—	25 000	336 730	156 556	641 965
Univ. British Columbia Vancouver, B.C.	208 128	362 500	—	65 000	209 728	226 773	1 072 129
Univ. Guelph Guelph, Ont.	303 232	—	—	54 700	393 019	239 723	990 674
Univ. Manitoba Winnipeg, Man.	529 380	75 528	—	—	63 000	174 019	841 927
Univ. Saskatchewan Saskatoon, Sask.	96 000	—	—	28 000	329 000	305 748	759 648
Univ. Toronto Toronto, Ont.	155 000	—	—	—	25 000	50 000	230 000
Subtotal	3 175 158	690 518	117 691	832 117	2 623 882	1 882 093	9 321 459

Continued on next page

Table A-2–*Continued*

	NSERC*	AgCan†	DF&O‡	Federal	Provincial	Industry	Total
Provincial laboratories							
B.C. Food Tech. Centre (BCFTC) Vancouver, B.C.	—	—	—	—	—	469 500	469 500
Alberta Ag. Food Lab Services Branch Edmonton, Alta.	—	—	—	—	80 000	—	80 000
Alberta Ag. Food Processing Dev. Centre Leduc, Alta.	—	—	—	—	348 351[1]	—	348 351
POS (Protein, Oil-seed, Starch) Saskatoon, Sask.	40 000	18 000	—	23 388	136 300	1 082 912	1 300 600
National Agri-Food Tech. Centre-MRC Portage la Prairie, Man.	—	—	—	56 074	370 000[1]	635 000	1 061 074
Prince Edward Is. Food Tech. Centre Charlottetown, P.E.I.	—	—	—	92 707	480 000[1]	194 133	766 840
Ministère de l'Agriculture, des Pêcheries et de l'Alimentation St-Hyacinthe, Que.	—	—	—	135 000	717 200[1]	—	852 200
Subtotal	40 000	18 000	—	307 169	2 131 851	2 381 545	4 878 565
Federal laboratories (Agriculture Canada research stations)							
Agassiz, B.C.	—	23 200[1]	—	—	—	14 000	37 200
Kentville, N.S.	—	500 000[1]	—	—	—	—	500 000
Lacombe, Alta.	—	1 109 400[1]	—	—	135 600	64 800	1 309 800
Morden, Man.	16 000	38 300[1]	—	40 000	—	45 000	139 300
St-Hyacinthe, Que.	—	1 256 150[1]	—	535 810	—	—	1 791 960
St-Jean-sur-Richelieu, Que.	—	25 000[1]	—	—	—	—	25 000
Summerland, B.C.	—	145 000[1]	—	—	—	—	145 000
Winnipeg, Man.	—	90 000[1]	—	—	—	—	90 000
Subtotal	16 000	3 187 050	—	575 810	135 600	123 800	4 038 260
Grand Total	3 231 158	3 895 568	117 691	1 715 096	4 891 333	4 387 438	18 238 284

Source: Based on an independent study conducted by the Food Network

Notes: For this table, food R&D funding includes operating dollars from research grants, research contracts, and research operating funds (federal and provincial laboratories); operating dollars, supplies, nonpermanent salaries, equipment, and materials. It does not include fixed costs such as permanent researchers' salaries, overhead, and major equipment costs (greater than $10 000).

University funding figures are based on CCUFSA figures for 1989-1990.

University of Manitoba figures include funding of projects carried out at the Agriculture Canada Winnipeg Research Station.

Industry funding figures exclude in-house R&D; figures represent funding contracted externally for R&D projects.

Federal funding to provincial labs in Quebec is through the Entente Canada-Québec (federal-provincial funding program). MAPAQ figures are for 1987-1990 period; St. Hyacinthe figures are for 1989-1990.

NSERC funding to the Morden research station is through the Department of Food Science, University of Manitoba.

The University of Toronto "total" figure of $230 000 does not include $50 000 from other councils. University of Toronto figures reflect funding for the food engineering program only.

The POS provincial lab figures reflect revenues received from contract research (with the exception of NSERC figures). Because of the unique operations of POS, an additional $1 101 253 (1990-1991) is required to maintain operations for client use. This figure is not reflected in the table because it is inconsistent with the definition of R&D funding used in this table.

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